Department
of Transportation
Urban Mass Transportation Administration

Highlights of the Transit Bus Technology Workshop

April 29 - 30, 1982

Sponsored by:
Office of Technical Assistance
Office of Bus and Paratransit Systems

In Cooperation with:
American Public Transit Association
Bus Technology Liaison Board

Prepared by:
Transportation Systems Center

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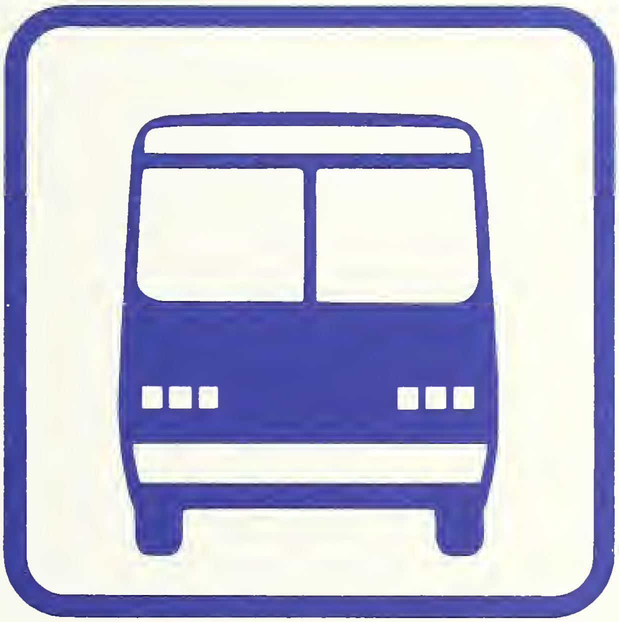

TECHNOLOGY SHARING A PROGRAM OF THE UNITED STATES DEPARTMENT OF TRANSPORTATION

Report No. DOT-TSC-UMTA-82-38

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of Transportation
Urban Mass Transportation Administration

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Research and Special Programs Administration
Transportation Systems Center
Cambridge MA 02142

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Washington DC 20590

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INTRODUCTION

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The Transit Bus Technology Workshop, held at the U.S. Department of Transportation, Transportation Systems Center on April 29-30, 1982, provided the Urban Mass Transportation Administration (UMTA) with current information on research, development, and technical assistance needed to improve the economy and performance of transit buses.

The workshop was sponsored by UMTA's Office of Bus and Paratransit Systems, in cooperation with the American Public Transit Association's Bus Technology Liaison Board.

Summaries of the individual speeches made during the general sessions and of the three working groups are contained in this document.

The format of the Workshop included:

- Introductory general session on the status of the transit industry and bus technology;
- Three parallel working groups reviewing: a) critical components of the vehicle; b) maintenance facilities and rehabilitation and; c) procurement aspects;
- Brief summary session for concluding remarks.

GENERAL SESSION

Summary of Keynote Address

Franz K. Gimmler
Deputy Associate Administrator
Engineering and Applications-UMTA

SUMMARY OF KEYNOTE ADDRESS

Several principles of New Federalism have had a significant effect on policies of the Urban Mass Transportation Administration. UMTA Administrator Arthur Teele's program for mass transit is based on three essential principles:

- First, there is unwavering determination to reduce Federal spending to fight inflation.
- Second, there is a determination to get the Federal Government out of programs and activities that simply are not Washington's business.
- And third, there is a commitment to reduce the intolerable burden of over-regulation.

Consistent with these, the budget proposed for Fiscal Year 1983 begins a three-year phase-out of operating subsidies. At the same time, the budget maintains a strong element of capital assistance, reflecting a conviction that capital investment in mass transit equipment and facilities is a Federal responsibility. It is, moreover, a means for providing needed assistance with a minimum of intrusion in the local decisionmaking process.

The Administration's continuing efforts in new legislation further reflect a full commitment to transit. The UMTA Administrator's block grant proposal is designed to deliver assistance in a way that allows local government to make the most economical decisions consistent with local needs and priorities. The user fee concept proposed by Secretary Lewis is an initiative designed to obtain a reliable source of funding by providing transit with the equivalent of one cent of the proposed five-cent gasoline tax increase.

Under New Federalism, economy and efficiency have emerged as key factors in shaping UMTA's technical program. The shift toward local responsibility has already brought about a higher level of attention to productivity and puts new emphasis on using improved technology and business methods to reduce costs.

In addition, the Federal role has shifted from one of development and deployment to one of technical assistance. The objective is to provide transit operators with assistance in management, planning, training, equipment, and facilities in accordance with the needs and priorities of the industry. This means concentrating UMTA resources on the problem-solving capabilities of research and technology. It also requires a high level of communication

between UMTA, transit operators, state and local government, and the manufacturing and supply industry.

UMTA has a number of new projects underway, in which technical and financial assistance is being provided to transit operators and state departments of transportation to solve problems that they recognize as critical in reducing costs. In parallel, regulations pertaining to the use of capital assistance funds have been reduced and altered to restore incentives to manufacturers to produce a more reliable product. Recent changes include evaluation of life-cycle costs, performance, and standardization in awarding contracts. Alternative procedures, such as competitive negotiations and two-step formal advertising, are also available to purchasers. Finally, the "bench mark price" proposal included in the Administration's recent legislative submission holds great promise for providing more flexibility.

The underlying purpose of these changes is to allow market forces and private industry to offer improvements which represent a cost-effective investment of private capital in research and development. UMTA's goal is to see a stronger and more competitive U.S. bus supply industry. This will occur if operators are allowed to buy more durable equipment that improves their productivity.

UMTA's technical assistance will focus on helping operators to solve current problems and on supporting the development of carefully selected technologies which can have a national impact on transit productivity. While it is important to remain open to new ideas, it is also necessary to make hard choices between expected benefits on the basis of a clear value priority structure. UMTA's program, therefore, will speed the evolution, but not attempt to revolutionize transit technology.

APTA's Bus Technology Liaison Board is fulfilling a vital function by advising UMTA on technical problems and identifying needs for technical assistance. It is clear from the attendance here that workshops such as this one in Cambridge can broaden participation in this process.

Current Activities of the APTA Bus Technology Liaison Board

James H. Graebner
Chairperson, BTLB & Director,
Santa Clara County Transportation Agency

CURRENT ACTIVITIES OF THE APTA BUS TECHNOLOGY LIAISON BOARD

The American Public Transit Association's (APTA) Bus Technology Liaison Board (BTLB) was established jointly by UMTA and APTA to advise UMTA's Office of Technical Assistance on technological problems and needs for research and development. The BTLB emphasizes reliability and product improvements rather than spectacular inventions. Both suppliers and operators are represented.

One of the BTLB's more important current projects is the preparation of guidelines for bus maintenance. Many small properties are forced to place inexperienced supervisors in their maintenance departments. The new APTA guidelines will describe the fundamentals of a maintenance program and provide examples of tested procedures and forms.

A special APTA subcommittee is preparing another set of guidelines to help properties put new buses into service. The entire acquisition process has been reviewed starting with receipt of the lowest bid. One of the subjects highlighted is bus inspection. At issue are the extent, method, and timing of manufacturer and buyer inspections. To address this problem area, the BTLB has organized on-site workshops for manufacturers and buyers and is drafting a set of bus inspection guidelines. The guidelines stress the importance of resolving problems before the buses are constructed.

A third set of guidelines covers the introduction of new products. Some common problems exist both with regard to whole vehicles and improved components. Operators cannot risk having to accept low bids on equipment that is unproven. On the other hand, manufacturers need to know the amount of proof through testing that will make their products marketable. New product guidelines for vehicles will advise manufacturers on introducing entirely new models. Component test guidelines will explain how to introduce improved components for existing vehicles. The operators have already made important contributions to these new product guidelines and it has become clear that some degree of industry consensus is needed.

Reliability is a major concern. Many operators believe that buses and bus components are less reliable today than in the past. Although UMTA is sponsoring research on this problem, funds are scarce. If the private sector is to invest in reliability improvements, manufacturers and suppliers must have some assurance that their products can be bought.

Bench mark pricing is another issue currently being addressed by the BTLB. Under the proposed bench mark pricing method, UMTA would provide a pre-established amount of grant funds -- for a baseline (stripped) vehicle. The property can then make the purchase without UMTA approval of the contract. If the property goes over the pre-established price, it must make-up the difference from its own funds. The BTLB has discussed the question of bench mark pricing and generally agrees that it makes sense in many circumstances. The major advantage is the elimination of red tape. Under the old system, it sometimes takes two years to obtain equipment after a grant is awarded.

Life-cycle costing is another important and continuing item on the agenda. The BTLB has reviewed recent experience with various approaches, but has not yet reached a consensus. Board members agree that life-cycle costs should be incorporated into the bidding process. The question is - how can this be done fairly and effectively?

The above issues are only a few highlights of the current agenda. Overall, the BTLB appears to be working as planned. Members do not always agree, but the continuing open forum is functioning as a useful mechanism for resolving problems, thanks to the hard work and good will of members and APTA staff.

Overview of the Current UMTA Program in Bus Systems

John J. Marino
Workshop Chairperson & Director,
Office of Bus & Paratransit Systems-UMTA

OVERVIEW OF THE CURRENT UMTA PROGRAM IN BUS SYSTEMS

UMTA's approach toward improving transit technology consists of working with transit authorities across the country to deal with some of the basic problems that bus and paratransit operators face.

Demand Considerations. The petroleum embargo of 1972-1973 had a major impact on bus transit. Ridership increased from an all time low of 3.5 billion trips in 1972 to 5 billion trips in 1980. At most, however, only six percent of daily work trips are currently made by public transportation. Bus and paratransit vehicles, which offer the advantage of flexible routing, may well face another increase in demand from commuters as fuel prices continue to rise.

This potential growth means large capital investments in the near future. Well-planned research could help to ensure that these investments produce optimal results for the public and for the transit properties.

Supply Considerations. Because the average bus has a useful life of 12 years, it will be necessary to produce 4000 new or rebuilt buses a year to maintain the current national fleet size of 52,000 vehicles. However, since the Advanced Design Bus was introduced in 1977, fewer than 3000 standard-size coaches have been delivered annually. This production level (approximately 0.5 percent of the total U.S. truck market) indicates that buses have been lacking in market strength. It appears that the uncertainties of the market have discouraged private industry from investing in new increments of production or in R&D projects.

In spite of these uncertainties, however, a number of manufacturers are planning or have begun construction of new production facilities. This apparently expanding list of vehicle suppliers contrasts sharply with the Transbus Program, which painfully demonstrated that administrative mandate is not an effective way of promoting technological competition in the bus market. The forces involved in these industrial business decisions are often subtle and impossible to predict at a distance.

Other factors also affect the supply industry. The controversial "White Book" specifications, for example, have had considerable influence over management choices and decisions. Procurements based solely on low bid are claimed to discourage product improvements and private-sector investments in R&D. It is clear that in order to do an effective job of stimulating technical

improvements, UMTA must work with the private sector to gain a better understanding of the private sector's financial environment and production status.

UMTA Roles. The rising cost of fuel is increasing the demand for public transportation, but it is also increasing its costs. The Federal Government, moreover, will be cutting back on its subsidies to transit properties as it moves to eliminate deficit spending. Bus operators will, therefore, need to use their equipment more efficiently and make it last longer. The Federal Government will help by eliminating regulations and administrative procedures which are not cost-effective.

UMTA is also re-examining its technical support role in this changing environment. Depending on needs and the potential for cost savings, UMTA may: 1) assess improved technology and procedures for use by transit operators; 2) share the cost of research and foster the implementation of new cost-effective technology; 3) act as an information manager to speed the adoption of techniques and equipment improvements; and 4) provide a means of introducing new equipment into revenue service without adverse impact on the transit operators.

UMTA's program in Bus and Paratransit Technology has moved rapidly to fulfill these roles and to address the problems of today. The program is divided into four elements: 1) Bus Systems and Technology; 2) Energy and Propulsion Technology; 3) Paratransit Systems and Technology; and 4) Industry Studies/Requirements Analysis.

Bus Systems and Technology

Bus operators have had considerable trouble in such areas as air conditioning, structural integrity, braking, and fuel efficiency. The object of the Bus Systems and Technology Program is to help solve these industrywide problems. Some of the projects being performed under this program are:

- o New Bus Equipment Introduction Program (NBEIP). Selected transit agencies are given an opportunity to buy and test new, innovative buses. Thus far, three grants have been awarded under this program.
- o Scania Bus Demonstration. Three standard size buses are being tested in revenue service in Norwalk, Connecticut under a one-year lease.
- o First Article Revenue Service Testing. Test procedures are being validated by MARTA using their new Neoplan buses.

- Bus Rehabilitation. A handbook is being developed that will aid transit managers in deciding whether to buy new buses or rehabilitate old ones.
- Advanced Air Conditioning for Buses. A screw-type compressor is being developed to replace the old piston-type compressor in bus air conditioners.
- Evaporative Cooler. An evaporative cooler is being developed by Denver RTD as a low-cost alternative to air conditioners in certain climates.
- Flxible 870 Air Conditioning. A special, heavy-duty compressor is being tested by MARTA on the 870 Advanced Design Bus.
- GM RTS-2 Air Conditioning. An RTS-2 bus air-conditioning system has been modified by VIA of San Antonio and is being documented so that other transit operators can use the designs.
- AM General Modifications. A number of bus subsystems reliability improvements are being developed and tested by the Sourthern California Rapid Transit District.
- Bus Brake Retarders. Electric, hydraulic, and engine brake retarders are being tested by Michigan DOT on "New Look" and "Advanced Design" transit buses.
- Bonded Brake Linings. The cost-effectiveness of retrofitted bonded brake linings is being studied.
- Transmission Improvements. Modifications to the V730 transmission are being tested by Michigan DOT. A replacement for the V730 will also be tested.
- Structural Evaluation. A computer model is being developed by Northeastern Illinois RTA to evaluate bus structures.

Energy and Propulsion Technology

The main goal of this program is to decrease the use of petroleum by switching to electric power, alternative fuels, or by using petroleum more efficiently in existing engines. Electrical propulsion is attractive because only 16 percent of the energy used to generate electricity comes from petroleum. Some of the projects being performed under this program are:

- Comparative Trolley Coach Propulsion System Evaluation. Three different trolley coach propulsion systems (AC induction, DC chopper, and cam) are being evaluated and compared by the San Francisco MUNI.
- Methanol Powered Bus. The Florida Department of Transportation is studying the feasibility of converting standard size diesel buses to methanol.
- Trolley Bus Emergency Power Supply. Dayton and Boston are each equipping one trolley bus with emergency propulsion systems so that they can operate off-wire.
- Battery Bus Evaluation. Battery-powered buses are being tested in transit service at Roosevelt Island in New York City as an alternative to gasoline/diesel buses.
- Flywheel Energy Storage for Electric Vehicles. A pure flywheel system is being developed for electric trolley buses. Laboratory tests are about to begin.
- Alternative Fuel Study. Port Authority of Allegheny County (PAT) is studying the full range of alternative fuels for transit buses.
- Hybrid Trolley Coaches. Trolley coaches equipped with both electric and diesel or gasoline power plants will be tested in revenue service at Seattle METRO.
- Bus Noise Reduction Kits. Portland's TRI-MET has developed a manual to help transit properties measure and reduce bus noise.
- Stored Hydraulic Energy Propulsion. TRI-MET has also completed a study on the feasibility of using a hydraulic system to store and reuse braking energy on buses.

Paratransit Vehicle Technology

The most prominent feature of paratransit vehicles is that they are acessible to wheelchair passengers. Prototypes developed by UMTA under the Paratransit Vehicle Technology Program have been praised by elderly and handicapped groups across the United States and Europe. The primary objective of this program, at present, is to demonstrate the use of mass-produced chassis. The mass-produced chassis significantly reduces the cost of paratransit vehicles.

Industry Studies/Requirements Analysis

TSC has conducted two studies for UMTA under this program:

- U.S. Transit Bus Manufacturing Industry. An analysis of the Bus Manufacturing Industry focused on demand, capacity, marketing strategy, entry, competition, and technology trends.
- Technology of Articulated Transit Buses. A study was conducted to provide urban transit managers and state DOT's with technical information on articulated transit buses.

In the future, UMTA will allocate less funds for direct procurement; more will be allocated for grants and cooperative agreements. More money will be spent on bus subsystems technology and the New Bus Equipment Introduction Program. UMTA will be able to spend less money on paratransit and on energy and propulsion technology in fiscal years 1982 and 1983 because many of its programs in these areas are now being completed.

In summary, UMTA has reoriented its bus R&D program. The new policy emphasizes upgrading buses that are already in use and helping transit properties to overcome specific problems at the subsystem level.

The Outlook for Transit Productivity Improvements

James F. O'Leary
General Manager, Massachusetts Bay Transportation Authority

THE OUTLOOK FOR TRANSIT PRODUCTIVITY IMPROVEMENTS

Because of changes made over the past year, the Massachusetts Bay Transportation Authority (MBTA) has become a leader in productivity improvement. The turning point came at the end of 1980. The MBTA was deeply in debt, and the communities that it serves refused to increase their subsidies. The crisis came to a head in December. The MBTA was forced to shut down, and the Legislature met to consider remedies. The Legislature made it clear that it would not underwrite inefficient operations. The solution adopted by the Legislature and the Governor was "management rights", the most significant management-labor reform in the history of the U.S. transit industry.

Under the new law, management has a guaranteed right to hire part-time employees, to assign employees to jobs on the basis of merit, to contract out for services, and to develop productivity standards. Management is explicitly prohibited from conceding any of these prerogatives. The purpose of "management rights" is to put the MBTA on the same footing as the private sector.

In March 1981, the courts enjoined the MBTA from implementing the reform. It was decided that management rights violated the U.S. Constitution and Section 13C of UMT Act. The state, however, won an appeal in October of that same year and began putting management rights into effect pending a review by the U.S. Supreme Court. So far, the reform has enabled the MBTA to save $50 million. An annual savings of $5 million, for example, was achieved by closing an obsolete power plant. The MBTA had been unable to close the plant before because the union would not let it reassign the employees who worked there. The option of contracting out for services (security services, for example) has produced the biggest savings. MBTA employees must now compete with the private sector to obtain certain kinds of work at the MBTA. The competition has greatly increased productivity.

The new policies have been successful partly because management has tried to work with the union and to inform them of impending changes in advance. Labor disputes continue, but management is making a continuing effort to foster cooperation.

We believe the MBTA is setting an example for the industry. Productivity has been declining across the nation, and current budget cutbacks make it imperative for transit properties to reverse this trend. The fight for

management rights will involve protracted negotiations and litigation, but management rights are a prerequisite for maintaining transit service.

QUESTION AND ANSWER PERIOD

Question - How does the MBTA plan to develop productivity standards?

Answer - The unions will compromise when management threatens to contract out for services, but as a rule, they resist any plans for increasing productivity. Union leaders are afraid of alienating their constituency. They have grudgingly accepted the reform because they are under intense pressure from all levels of government.

The MBTA is currently negotiating a new contract with the biggest union. One of management's principal demands is that productivity committees be set up. The committees will establish productivity standards. We hope that future wage increases will be based, in part, on productivity.

Question - How are work rule issues being resolved?

Answer - The general manager tries to have his staff handle routine labor problems. (Who, for example, should fix broken windows - sheet metal workers or machinists?). In the past, such disputes often went to the general manager or the Governor. The current policy is to keep these things nonpolitical and deal with them at the staff level.

The general manager is trying to develop a good working relationship with the four largest unions. The big unions play a key role in labor relations because the smaller unions usually follow their lead.

Question - Will management rights affect the number of different unions?

Answer - Some of the small unions (10 or 12 members) will probably consolidate with larger ones. But most of the unions will retain their independence. Compulsory consolidation has been considered, but it appears to be unconstitutional.

Question - How will productivity be measured?

Answer - Now that the MBTA has won the right to set productivity standards, it must develop an information system to decide what those standards should be. UMTA is expected to help with this problem. As the MBTA sets productivity standards, it will also acquire a better understanding of maintenance requirements. The improved maintenance cost information will help in future procurements by allowing us to specify a more reliable and maintainable bus. This can also be expected to have an effect on Federal procurement policies.

A Transit Operator's View of Technical Assistance Needs

Ernie A. Miller
General Manager, Metro Regional Transit Authority, Akron, OH

A TRANSIT OPERATOR'S VIEW OF TECHNICAL ASSISTANCE NEEDS

To identify the technological needs of small bus systems, a number of operators were consulted in different sections of the country. Their answers, which also reflect some of the concerns of medium-sized and large properties, indicated the following needs:

1) Improved manual route scheduling;

2) Simplified computer programs for accounting, inventory control, grant applications, etc,;

3) Lists of available hardware and software and names of users;

4) Computer programs to analyze the public's trip habits so that people can be persuaded to use public transportation;

5) Computer programs for Section 15 reports, specifically onboard trip reports;

6) A means of discouraging people from using private automobiles;

7) Better vehicles — current models are too complicated mechanically and consume too much fuel. The lightweight models, moreover, lack durability;

8) New schools to train maintenance men; and

9) A smaller, more fuel-efficient diesel transit coach.

Manual route scheduling requires an intimate knowledge of local conditions — work schedules, traffic patterns, geography, etc. RUCUS and MINI-RUCUS can help in a multitude of ways, but they cannot replace the scheduler. The best way to train a scheduler is to hire an experienced retired employee to teach him. An outside consultant would have to familiarize himself with local conditions before he could even begin to work on scheduling problems.

Many transit operators want simplified computer programs. A wide variety of programs are on the market, and it is relatively easy to obtain information about them. (APTA and UMTA can help.) Interested operators should contact properties that have already set-up computer systems. They will be happy to discuss specifications, bidding procedures, costs, and other related matters.

Maintenance has become a serious problem for small operators. Transit vehicles are more complicated mechanically than ever before, and at the same time, there is a shortage of experienced mechanics. One way to help would be to return to basics - to produce a selection of simple, basic transit vehicles. Other ways of helping would be to facilitate the training of maintenance men and to encourage service representatives to make frequent visits — even after the warranty on new equipment has expired.

In recent years, transit operators have come to recognize the importance of marketing. APTA has a special marketing committee, and it will gladly help any transit property that needs marketing advice.

Manufacturers' View of Bus Improvement & the Roles of Industry & Government

Edward R. Stokel, General Motors
Edward N. Kravitz, Grumman Flxible
Clarence I. Giuliani, Neoplan USA
John Bowerman-Davies, Mack-Renault, Inc.

PANEL MEMBERS' REMARKS

Edward R. Stokel, Director of Public Transportation, GMC Coach and Truck Division, General Motors Corporation

Research and development are both time-consuming and costly. On the average, only 2 percent of all research projects yield marketable products. At present, the General Motors Corporation must divert a large part of its R&D budget to the task of meeting EPA and NHTSA requirements.

Is there a place for both UMTA and the private sector in the field of research and development? The answer is an unqualified "yes," however, proprietary rights of the private sector must be protected. This is a serious problem that was not adequately resolved in the Transbus Program.

The low-bid philosophy is a major impediment to privately financed research and development. Fortunately, the government has started to move away from procurements based entirely on low bid. The industry's overall volume of sales is another important Factor. Because the bus industry has been selling only 3500 units per year, the market is not really profitable enough to support large-scale research and development.

Motor vehicle safety standards are an area in which government and industry could work together. It is questionable whether or not the spate of new regulations is cost-effective. For example, a transit bus traveling at 60 mph must be able to stop within 293 feet. However, transit buses can very rarely travel that fast. This is typical of the kind of requirement that should be examined more carefully.

Edward N. Kravitz, Vice President, Engineering, Grumman Flxible Corporation

The private sector needs help from UMTA in the following categories of research and development: braking, air conditioning, accessibility for the elderly and handicapped, and alternative energy sources.

It would be beneficial if UMTA could help to develop uniform life-cycle cost procedures. Defects in the current procedures have caused many inconvenient delays in bidding. Part of the problem is that some vehicles are difficult to compare (Advanced Design Buses (ADB) and New Look coaches, for example).

Industry would be in a better position to avail itself of Federal grants if the government would cut down on red tape. Grumman, for example, is collaborating on a project with the Metropolitan Atlanta Rapid Transit Authority (MARTA). The parts arrived in Atlanta six months ago, but because of bureaucratic delays the work has not begun.

Transit operators who are planning to order new equipment should meet with the manufacturers six to 12 months before the bidding to warn the manufacturers of any possible changes in the specifications. Because of short backlogs, it is impossible to make changes after a bid is accepted and a contract signed.

Bus manufacturers must guard against people who would force them to discard proven designs and use untested components. The way specifications are currently being written, the manufacturers are vulnerable to such pressure.

The bus manufacturers need help from UMTA to continue with long-term research and development. The market is not profitable enough to support these projects. The Alternative Fuels Program, for example, would be impossible without government funding.

Clarence I. Giuliani, Sr., Vice President, Customer Services, Neoplan USA Corporation

Buses have changed over the past 30 years, but they have not really improved. On the contrary, they have become more complicated and require a larger, better-trained maintenance force. That means that current vehicles are less maintainable and less cost-effective. There is little prospect that improvements will be made. Demand is so low that bus manufacturers have no incentive to develop better products.

The government — at all levels — could help if it would reduce its involvement in the transit business. Maintenance men are trammeled by over-regulation.

When bus specifications are interpreted, the operators frequently request changes and expect the manufacturers to bear the added cost. The operators must remember that the manufacturers are entitled to make a profit. If any changes are desired, the operators must pay for them.

Riders and taxpayers have a vital stake in the transit industry, but they are often ignored. The interests of these two groups must be recognized when specifications are written and interpreted. Otherwise, they will clash with

each other and with the industry. Public transportation could not endure that kind of conflict.

John Bowerman-Davies, Director of Planning and Strategy, Renault Bus Division, Mack-Renault Inc.

Renault is the leading manufacturer of electric trolley buses. As petroleum becomes more expensive and scarcer, many properties are going to view the electric trolley bus as an attractive alternative to diesel buses. Petroleum is seldom used to generate electric power. The trolley bus, moreover, is more flexible than LRV's or rapid rail vehicles because it does not require tracks. Laying tracks means making a multidecade commitment to a particular route. It is much easier and much less expensive to put up new wires. Renault also produces battery buses, which are now technologically suitable for revenue service. Battery buses can travel eight miles for every three minutes of recharging.

Government support would be essential if a property decided to buy trolley or battery buses. The equipment required would be expensive. It is necessary, however, to draw a line between assistance and interference. The New Federalism will give people a better idea how the government can help.

QUESTION AND ANSWER PERIOD:

Question - General Audience

In what part of Pennsylvania does Neoplan intend to open its second American plant?

Answer - C. Giuliani

We have not decided yet. We will be meeting with representatives of the Pennsylvania Department of Commerce to choose a location.

Question - J. Marino

The differences between the ADB and New Look buses are becoming less and less marked. It it possible, what with life-cycle costing, that in the next 12 to 18 months bus specifications will cease to be specifically "White Book" or "New Look"?

Answer - E. Stokel

Yes, that is a probability. A city like Toledo or Phoenix might submit a set of specifications that six or seven different manufacturers could bid on. Each proposal would be based on the bidder's own primary product.

Comment - E. Kravitz

The ADB bus has many expensive features (cantilevered seats, for example) that are not found on the New Look bus. It is very difficult for manufacturers to shift from one design to the other.

Obtaining Better Equipment-A Component Manufacturer's View

Daniel Hancock

Chief Engineer, Products, Transmission Operation, Detroit Diesel Allison-GM

OBTAINING BETTER EQUIPMENT - A COMPONENT MANUFACTURER'S VIEW

Reliability development is more than a measurement technique. It is a method of eliminating failure models. Reliability development typically comprises three phases:

1. Component Development. Reliability objectives are set, and multivariable probes are conducted.

2. Systems Development. The interaction of components, i.e., the functioning of a system, is tested in a user environment. The vlosed-loop control method is used to collect and analyze data.

3. Customer Fast Feedback. Data is collected on units in service.

The object of component development is to achieve zero failures within an operating rectangle, i.e., a preset combination of stresses brought to bear on a system over its maximum expected life. These stresses include vibration, temperature, load, etc. The operating rectangle is plotted on a graph as shown in Figure 1.

The classical approach is to exceed the maximum expected life and continue until the parts start to fail. There will be a certain amount to data scatter because the samples will vary in strength. The test is usually stopped before all of the samples have failed. The corresponding graph can be taken as a fatigue or endurance diagram.

If the stress is increased, failures will start to occur earlier and will define a materials strength distribution curve. This curve can be projected into the operating rectangle to show whether there is a probability of failures occurring in the operating area. The probabilities derived in this manner would not be revealed by the classical approach.

The accelerated method is used to test Universal Electric Control Systems (UEC) controls and other electronic components. The stress is increased at fixed intervals of time to force failure of all the samples. The resulting curve is well defined and enables the analyst to determine with great accuracy whether the operating area is affected. Using other statistical methods, the analyst can plot a Weibull slope for the failure points obtained, project that slope into the smallest percentages of failure, and verify the percentages within confidence limits.

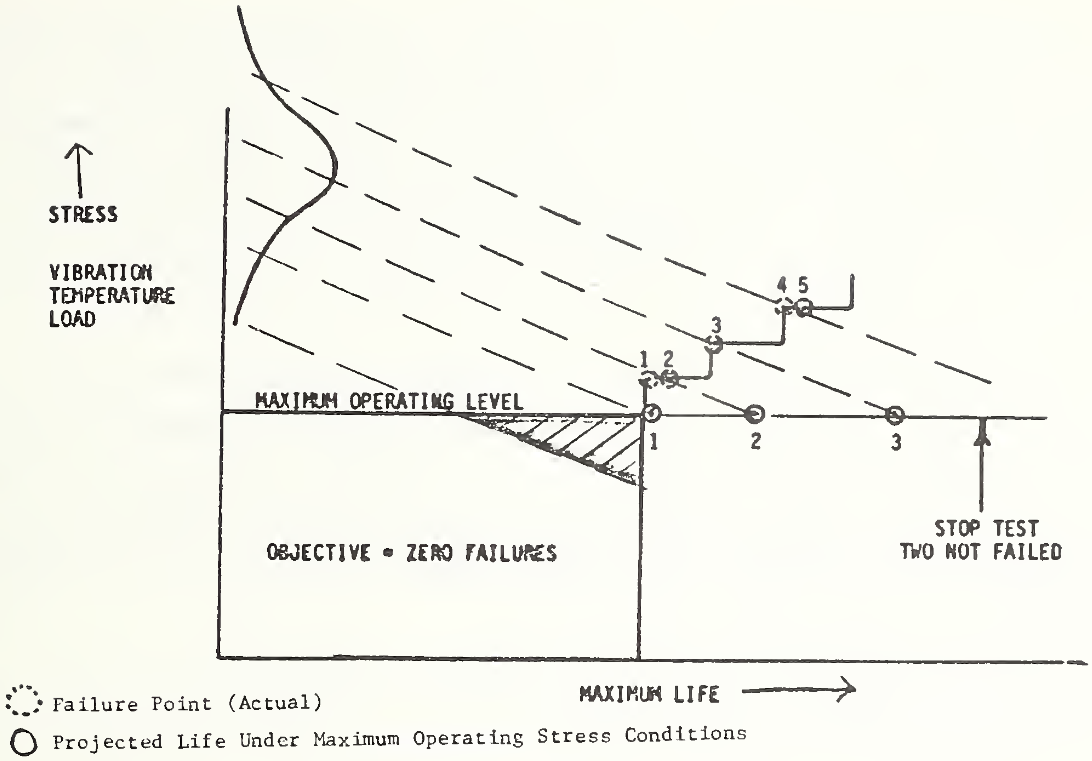

FIGURE 1. ACCELERATED RELIABILITY TESTING

Multivariant testing means subjecting the samples to combined environments - extreme heat and cold, for example, in the course of a single test. Multivariant testing accelerates failures and enables the engineers to uncover many problems. in the laboratory, i.e., before the prototypes are tested in the field.

The Duane Growth Model is used for system testing. Under this method, the analyst plots operating hours against time between failures. The axes are logarithmic. This type of graph shows how reliability increases as the equipment is used and defects are eliminated. A characteristic growth rate is obtained if certain conditions are met: 1) Testing must be done in a user environment; 2) Successes and failures must be carefully monitored; 3) An intensive closed-loop feedback system must be set up; and 4) Defects must be promptly corrected.

The Duane Growth Model produces a linear graph. If the expected growth in reliability is replotted on nonlogarithmic axes, this line becomes a curve. In practice, moreover, there are two curves - the ideal curve plotted at the outset of the project and the real-life curve that results from experience in the field. The real-life curve is lower because it takes time ti pinpoint failures, test new designs, and distribute modified hardware.

When modified hardware is put on line, it undergoes a period of observation. At the end of this period, the design changes are "scored," i.e., the effectiveness of the changes is estimated. The scores, which are determined by an independent committee, generally reflect the ratio of pre- to post-moditication failures. The engineering reliability department uses the scores to derive an "expected" or "adjusted" failure rate. This process is known as a design control loop.

Reliability development requires accurate, accessible information. Detroit Diesel Allison (DDA) has therefore developed a network of agents to gather data from the properties using its hardware. For the most part, their job involves examining service records, but they also study and report incidents that occur in the field. The information that these agents obtain enters a computer data bank.

Another source of data is "fast feedback." DDA maintains regular channels of communication with certain customers and thereby gathers statistical information on the performance of its products. (The properties selected for this program represent a predetermined range of operating conditions.) The performance data is fed into a computer and is used to generate failure rate curves.

There are several ways in which the bus technology community can help to develop reliable components: 1) Define minimal standards and set realistic objectives; 2) Grant funds to support the development and testing of new hardware; 3) Use data control to gather data on reliability; and 4) Assist failure with mode researchers.

Improving Bus Maintenance-
Highlights of the Recent UMTA/TRB Workshop

A.B. Hallman
UMTA Office of Service &
Management Demonstration

IMPROVING BUS MAINTENANCE - HIGHLIGHTS OF THE RECENT UMTA/TRB WORKSHOP

In response to growing concerns in the transit industry, UMTA requested the Transportation Research Board to convene a working conference on bus maintenance. The conference, held during the week of April 13, 1982 in St. Louis, Missouri, was structured to exchange information on current practices, determine technical assistance needs, and help UMTA formulate future research and development policies.

Workshops were set up to accomplish four general tasks:

1. To pinpoint various ways in which the maintenance practices of the transit industry are inferior to the maintenance practices of other industries.
2. To identify obstacles to the improvement of current maintenance practices - including obstacles to innovation.
3. To determine what kinds of research and development should be emphasized.
4. To recommend criteria for allocating Federal funds for research and development.

Maintenance problems were addressed in five concurrent workshops. Transit maintenance managers cited the general lack of property-level maintenance policies and the practice of failure-based maintenance as serious common deficiencies. In addition, managers feel that it is not possible to audit the performance of maintenance operations, perform statistical analysis, or predict life-cycle costs without systems and technology that can provide feedback for analyzing failures. Participants recognized the standard solutions to their problems would be difficult to obtain because of the wide variations in transit agencies.

Management's Role. Recommended activities that would assist the maintenance manager in developing a more efficient organization include:

- An information exchange on practical maintenance management experience.
- Criteria for developing preventive and failure-based management programs and for life-cycle cost predictions.

- Development of diagnostic methods to assess the condition of components and predict failures (for example, an in-house oil analyzer).
- Handbooks on maintenance management and maintenance planning and budgeting.
- More efficient dissemination and implementation of UMTA-sponsored research and developments.

Management Tools for Improving Maintenance. Key recommendations for technical assistance in this area include:

- Information on available management information systems and matching hardware.
- Development of improved management information systems, software, and training methods.
- Information to aid in the selection of computer hardware.

Human Resources for Maintenance. The principal conclusion of this working group was that regional training centers would be the best and most economical approach for providing the intensive and continuing training needed in this field.

Facility and Equipment Needs. Although this working group did not feel that new research and development was needed, it recommended:

- Formation of an APTA subcommittee to disseminate information on facility construction and equipment.
- Preparation of a design guide that would treat building functions in modular form.
- Seminars for exchange of information of facility design and equipment.

Vehicle Design, Acceptance Testing, and Maintenance Support Services. This group addressed the issues of obtaining more reliable and maintainable vehicles. Recommendations included:

- Simplification of vehicle systems and subsystems and empirical measurements of the labor hours required to remove and replace components.
- Creation of the APTA bus specification information exchange, making base specifications available to all operators.

- Use of Sections 1, 3, and 4 of the White Book.
- Development of diagnostic equipment and readable maintenance manuals.
- Improved quality control and more extensive prequalification tests.

WORKING GROUP MINUTES

WORKING GROUP 1:
Bus Subsystem Improvements

Chairpersons:

Frank W. Venezia
Superintendent, Shops, Maintenance Dept.,
Chicago Transit Authority

Thomas Okasinski
Mgr. of Equipment, Southeastern Michigan
Transportation Authority

Working Group Organizer:

C.J. Harrington
Urban Systems Division
Transportation Systems Center

ENGINE IMPROVEMENTS

Brian S. Henriksen, Staff Engineer, Diesel Engines, Detroit Diesel Allison

Mr. Henrikson addressed the reliability and fuel economy of the 6V-92TA engine, including programs undertaken to date and future improvements in fuel economy. The 6V-92TA offers significant advantages in weight, fuel economy, and noise reduction over the 8V-71N, plus the capacity to meet future emission standards.

APTA was concerned about the reliability of the 6V-92TA engine due to the lack of in-service experience. Field testing of the engine began in October of 1978 and was conducted in five cities (Seattle, Salt Lake City, Atlanta, Denver, and Detroit). Mileages on test engines are now over 200,000.

In July 1980, the first of 260 engines was built for the Miami Metro Transit Agency. To deal with engine problems in the field, DDA developed their "fast feedback system". This system was initiated in Miami and then extended to Santa Clara, Los Angeles, and Denver. Under this system, any major engine failures are reported directly to the DDA Service Department who refer them to the Engineering Department. Each reported failure requires a corrective action be taken to fix the problem in other buses and to prevent future occurrences. Information is fedback much faster through this system than the warranty system which takes at least 90 days.

DDA feels that the reliability of the 6V-92TA is now comparable to the 8V-71N. Regarding fuel economy improvements, DDA had predicted a 9-percent fuel economy improvement over the 8V-71N model. SAE/DOT tests show a 12-percent improvement, and Utah Transit Authority testing also show a 12-percent improvement. In other comparisons, maintenance time for overhaul of the two engines appears comparable. The 6V is easier because it has only six cylinders, but additional time is needed for the turbocharger. These factors seem to average out. Acceleration at the low end of the speed range also seem comparable for both engines.

For the 1984 model year, DDA is predicting another 13-percent improvement in fuel economy based on lab tests. This model will contain a number of new features. DDA is currently working on an electronic control system with built-in diagnostic capabilities which will replace the current engine control system.

TRANSMISSION DEVELOPMENTS AND FUTURE PROGRAMS

James D. Swaim, Manager, Off-Highway Service,
Detroit Diesel Allison

Jim Swaim described the recent history of the V730 transmission as well as transmission improvements under development by DDA. A Customer Support Program was established at DDA for the V730 transmission. About the same time that the program was announced, a problem was found in the rotating clutch and lockup area. "Scarf-cut" seals were identified as the source of the problem. The introduction of a new Dupont seal material, SP-21, and the elimination of the "scarf-cut" proved to be an effective solution. Unfortunately, the "scarf-cut" seal was introduced at varying times in the transmission serial numbers (anywhere from 9000 to 18,481). As a result, it is hard to define what reliability means in this time frame. The TSC report on the subject reflects this finding.

DDA has been monitoring bellwether fleets with V730 transmissions in Los Angeles, Miami, and several midwestern cities. "Mean miles between failure" is approaching 150,000 to 200,000 which is the goal DDA had established for this transmission.

At present, it is not clear whether the industry will choose the T-drive or the V-drive as a standard. DDA is prepared for either eventuality. They are now working to incorporate the improvements found necessary in the V730 for transit operations into the HT740 transmission in case the T-drive becomes standard. They are proceeding with a test program on the V735, but product introduction of this model is on hold.

Currently under development is a universal electronic control system. This system should be an improvement since the cables required by the present hydraulic system contributed to the V730's problems. Also, the ability to electronically control shifts and shift points will improve fuel economy by as much as 9 percent according to test results.

A fly-wheel hybrid transmission is also under development. A rotating disk (6" thick and 22" in diameter) is combined with a continuously variable (or "hydrostatic") transmission. The fly wheel is accelerated as the vehicle brakes; this braking energy in turn is used to reaccelerate the vehicle. The

fly-wheel transmission results in lower engine torques and speeds, longer brake life, reduced emissions, and improved fuel economy. Computer simulations have shown up to a 60 percent improvement in fuel economy with this type of transmission. DDA hopes to have such a transmission in revenue service by 1985 or 1986.

Heinz Gutmair, Zahnraederfabrik Renk, A.G.

Mr. Gutmair described the RENK transmission, manufactured in West Germany. RENK incorporated a retarder into their transmission to improve fuel consumption and brake lining life. Rather than add new parts, RENK integrated the retarder into the converter, using components of the converter as a retarder.

The transmission is entirely controlled by a solid state electronic control unit. The unit tells the transmission what to do based on signals transmitted from the driver and from the engine. RENK has a number of years of experience with the solid state control system and has had few problems with it. The solenoid has been the weakest part of the system, and high-operating temperatures did affect the inductive transmitters. An emergency system has been developed which goes into effect if the transmitters fail. The retarder is cooled by the regular engine cooling system.

This transmission was incorporated into 400 M.A.N. articulated coaches. One retrofit program was carried out, but other than that the transmission has proven very reliable. West German studies show the retarder extends brake lining life two to three times, depending on operating conditions.

James Wanaselja, Project Engineer,
Voith Transmissions, Inc.

Mr. Wanaselja spoke briefly on the Voith transmission, also of West German manufacture. Like the RENK, the Voith has an integral retarder and an electronic control system. The Voith transmission has a special design feature which results in less shifting in stop-and-go traffic. Voith has about a half dozen transmissions operating in the U.S. currently. They have over 8 billion miles of experience worldwide on transit bus transmissions.

Kamel Boctor, Manager, Technology Development Unit
Bureau of Urban and Public Transportation
Michigan Department of Transportation

Kam Boctor described the UMTA/MDOT Transmission Program. Data was collected from Michigan transit systems on typical failures of V730 transmissions. The data showed that some failures were due to design problems (i.e., the responsibility of transmission manufacturer) and other failures were due to environmental problems (i.e., the responsibility of the bus manufacturers).

Part I of the program deals with environmental problems and will evaluate ways to reduce V730 transmission failures. Methods to be tested included: (1) lowering the transmission fluid temperature by relocating the air-conditioning condensor and/or adding an auxiliary cooler, by using an Everfill reservoir or by using different transmission fluid; (2) changing the power takeoff by driving the air-conditioning compressor off the engine instead of the transmission PTO, using a damper with the Trane compressor, and testing other compressors, and; (3) changing the shifting control by using universal electronic controls or a Bennet hydraulic remote shifter.

Under Part II of the program, different types of transmissions will be procured, installed, and evaluated in revenue service including the V730 and V735 transmissions with the latest modifications, universal electronic controls, and hydraulic retarders, and perhaps other transmissions. Under Part III of the program, the V730 transmission will be tested as part of the New Look Rehabilitation Program.

STRAIGHT-IN VS. ANGLE DRIVE TRANSMISSION

Clarence I. Giuliani, Sr., Vice President, Customer Services,
Neoplan USA Corporation

Mr. Giuliani presented his views on the advantages of the in-line (straight-in) versus the angle-drive transmission. The first bus bids Neoplan obtained in the United States were 50 buses for Atlanta and 44 buses for Milwaukee. Both cities wanted a GM "New Look" style of bus. The buses were built with a transverse engine configuration and a V730 transmission. But it soon became apparent that the majority of future orders would be tied to the White Book configuration. After comparing both systems, Neoplan decided

to go with the in-line configuration. Currently, Neoplan has 1300 coaches on order with an in-line configuration.

In Mr. Giuliani's opinion, the transverse engine configuration was a good design initially, but evolved over time into an impractical one. The need for more power and for air conditioning resulted in an engine compartment so full of hardware that it was very difficult to work on.

Among the advantages of the in-line configuration, according to Mr. Guiliani, is its better weight distribution. Heavy components such as the radiator, the air-conditioning compressor, and other auxiliary units are removed from the engine cradle. In addition, stress is absorbed by the strong central spine member of the bus body rather than by the outer edges of the body.

By using the in-line configuration, it is possible to reduce the wheel base of the vehicle back to the New Look-type configuration, making turning corners easier. Another advantage is the ability to direct air through the engine radiator without blowing hot air over the rest of the engine and transmission, an important factor in hot climates. Engine and transmission removal can be done without disconnecting the air-conditioning system. Demonstrations at the plant showed that three people could remove and replace the engine-transmission assembly in 20 to 25 minutes.

Although it is true that the HT740 in-line transmission is new to the transit field, experience with the HT740 in the truck and inter-city bus fields should mean there will be less debugging than there was with the V730 when it was first introduced. Neoplan will release its first bus with an in-line configuration in about 6 weeks.

Gil Pegg, Coach Parts and Service Manager,
GMC Truck and Coach Division

Mr. Pegg presented a differing point of view on the advantages of the in-line versus angle-drive transmissions, tending to favor the current configuration. Mr. Peff expressed concern about the shorter wheel base of the in-line configuration affecting angles of approach and departure as defined in the White Book. The shorter wheel base may lead to more accident damage. If the wheel base is kept long, the turning angle can be kept sharp.

Another concern was with the weight distribution. Because there are two wheels in front and four in back, the ideal weight distribution for a bus is one-third in front and two-thirds in back. This distribution results in better handling and steering, better tire life, and a better braking configuration. The weight distribution can also affect the long-range durability of the bus. Although a one-third, two-third distribution can be achieved using either configuration, it is easier with the transverse configuration. From a passenger point of view, this distribution should be obtained without changing the floor level, should not involve a lot of protusion of the engine and transmission, and should keep the maximum seating space.

The accessibility of the engine in the engine/transmission in-line configuration can be a problem. In-frame overhauls can be done with either configuration, but they are easier with the transverse configuration. For overhauls on the in-line, the engines are frequently removed from the coach.

Current shop equipment, such as dollies and hoists, may or may not be compatible with an in-line configuration. If existing garage facilities do not have pits, this would be an additional cost factor. Daily service checks on the in-line transmission are more awkward since they require the use of a 48-inch dip stick. The transverse requires only a 24-inch stick. Fewer belts are necessary with the transverse configuration. Both the air-conditioning compressor and the engine alternator are gear-driven off the back end of the engine.

Although it is true that the HT740 has a good reputation in the trucking and inter-city bus industry, this is "over the road" experience and can not be equated to transit experience on inner-city coaches.

Following Mr. Pegg's remarks, Mr. Giuliani commented on several of the issues raised. The Neoplan in-line configuration bus achieved the one-third, two-thirds weight distribution without any problems; there was no change in the inclination of the floor or in seating capacity. Also in changing the wheel base, the bus still complies with the specified angles of approach and departure. Regarding the 48-inch dip stick, Neoplan is considering using an Everfill unit which would indicate whether the transmission has fluid or not rather than measuring the fluid level. Regarding overhauls, it is easiest to pull the whole transmission when working on it. It takes about an hour to disconnect and reconnect it. Regarding transit experience, Mr. Guiliani noted that 55

Eagle "over-the-road" buses have been used for in-town operations in Houston without problems.

Mike Buckel, Senior Associate,
Booz, Allen and Hamilton

Mike Buckel described the UMTA-sponsored performance assessment of the in-line versus the transverse configurations. This study found the HT740 to have about 5 percent better fuel economy than the V730 because its fourth gear is a "lower low." Also the torque converter is in the converter mode less often, and less heat is transmitted to the transmission fluid.

BRAKE IMPROVEMENTS

Gil Pegg, Coach Parts and Service Manager,
GMC Truck and Coach Division

Mr. Pegg described "third generation" brakes developed for the RTS-04 series coach. A nonsymmetrical brake lining has been developed which results in a 20 percent increase in useable lining at the point where the most wear occurs. This means a longer period between brake relinings. The design also produces a better heat sink because of its increased area. The new brake drum is heavier than the former drum, but the disadvantage of increased weight is offset by the above-mentioned advantages.

The brake shoes and shoe mountings will remain unchanged. All parts for the "third generation" brakes will be interchangeable with all buses currently on the road. There may, however, be need for a plumbing change. GMC Truck and Coach Division has an application pending with NHTSA regarding FMVSS No. 121. Hopefully, a plumbing change will not be required. GMC will issue a bulletin containing part names and numbers for the new system.

Tubeless tires are preferable to tube tires for use with these brakes due to the generated heat. Bonded brake linings will last longer, but it is not clear that they are cost-effective since they currently cost more. If more properties begin to use bonded brake linings, the cost should come down. SEMTA will be testing bonded brake linings under an UMTA demonstration grant, and test results will be available to the transit industry.

One reason for early brake lining failures of the "third generation" brakes has been traced to the swelling of Apex 80 material resulting in an "interference fit" and hence increased wear. The action recommended to alleviate this problem was to hand adjust the brakes using a hack saw blade rather than a feeler gauge since this method results in adequate clearance.

"Third generation" brakes are currently in use in New York City and other locations. Some of these brakes are lasting 25,000 to 30,000 miles compared to the previous average brake lining life of 18,000 miles.

RETARDER DEVELOPMENT AND TESTING

a. ELECTRIC RETARDER

David J. Ganzhorn, Sales Engineer,
Midwest Retarder, Inc.

David Ganzhorn described the Telma retarder of which his company is the U.S. representative. The Telma retarder was developed in Europe 35 years ago to prevent runaways on steep mountain roads. In France, legislation requires a backup braking system. Although initially required for safety reasons, it was found that retarders increased brake life by four to 10 times and increased tire life 10-20 percent.

Retarders were first introduced in the United States also for safety reasons. The conversion of motor home chassis into small transit vehicles during the energy crisis resulted in some severe braking problems which were solved by the addition of retarders. Midwest Retarder introduced retarders to the larger transit properties following this initial introduction.

In the electric retarder, stationary coils are used to set up a magnetic field in a set of large cast iron rotors. When the rotors turn in the magnetic field, a strong opposing force develops. Heat develops in the rotors in the form of eddy currents. The fan-shaped rotors, mounted under the vehicle, dissipate heat to the air.

The lighter-weight Telma retarder used on smaller vehicles is bolted directly to the chassis. The model used on most full-size transit buses is a heavier unit and is bolted to the transmission. A Rockwell International computer study showed a problem with the rear axle heating up due to the presence

of the retarder, but other testing has shown the differential actually runs cooler with the retarder on.

In an attempt to gain acceptance for the retarder, Midwest gave retarders to major U.S. transit properties. The hand control system used in Europe proved impractical here. U.S. drivers could not be relied on to operate the retarder. Consequently, Midwest developed an automatic control system to activate the retarder. The system is integrated into the regular braking system and involves relays at different pressure settings. When the driver presses down on the brake pedal, a switch closes sending a signal to the relay box, which sends current to the retarder. When the bus stops, the retarder kicks off automatically.

Retrofitting of retarders is easy, but can be expensive. Rehabilitation programs are a good time to retrofit a retarder since they involve dropping the rear axle and taking the differential apart. Rockwell International makes all of the mounting parts. If a property is not sure they want retarders, it is worthwhile to have the mounting parts factory installed on new vehicles so that a retarder can simply be bolted on at a later date. Retarders are currently being fitted on different vehicles around the country, including the RTS, the Flxible 870, and the Flxible Metro.

All braking by the retarder is done by magnetic fields. Once the unit is mounted, there is no maintenance of the retarder unit itself. The retarder has good salvage value since there are no wearing parts. Some maintenance is necessary for the electrical system. There have been some problems with the relays (premature failure of points) which is why Telma is going to a solid-state system. Salt corrosion of electrical parts was initially a problem, but the retarder was redesigned so that these parts are covered. The retarder unit is heavy, the larger model weighing 400-500 pounds.

Retarders will perform 80-90 percent of the braking necessary to bring the vehicle speed down to 2 or 3 mph. Denver has 127 GMC coaches with retarders. At 50,000 miles, they still have half the brake lining left. Previously, brake linings lasted 16,000 to 18,000 miles. Kansas City was having low brake lining life (2000-3000 miles) with small vehicles due to the heavy passenger load. With the CE30 retarder, brake linings have gone 12,000 to 15,000 miles and are still in good condition. Other properties using the retarder include Seattle,

San Francisco (MUNI), Orange County, Los Angeles, San Diego, New York City, Richmond, and Pittsburgh.

Advantages of the retarder besides increased brake life include: decreased vehicle downtime, less frequent brake adjustments, less inventory of brake-related parts, less heat in brake drums, longer tire life (10-20 percent), more time for preventive maintenance, and fewer road calls.

b. HYDRAULIC RETARDER

Jerry Trotter, Engineer,
Detroit Diesel Allison

Jerry Trotter of Detroit Diesel Allison described the hydraulic retarder produced by his firm. The hydraulic retarder was also developed initially in Europe in response to legislation requiring a supplementary braking system. This retarder unit is currently being adapted for U.S. transmissions, including the V730, the HT740, and the MT644.

The DDA retarder involves a hydraulic portion and a clutch portion. The clutch pack is necessary for quick response and for lower speeds. The clutch gives additional torque capacity at low speeds and gives an overall retardation torque. Test programs are underway for three transmissions to see the effect on brake lining life. Early tests show a very significant reduction in heat in the brake linings. The production schedule for the V730 transmission retarder is "on hold." DDA is just beginning to adapt this retarder to the HT740 transmission.

c. RETARDER DEMONSTRATION PROGRAM

Kamel Boctor, Manager, Technology Development Unit,
Bureau of Urban and Public Transportation,
Michigan Department of Transportation

Kam Boctor of the Michigan Department of Transportation (MDOT) next outlined their program for evaluation of vehicle retarders funded under a grant from UMTA. The objectives of the program are to study the feasibility of installing retarders on advanced design buses and to study the impact of retarders on the performance, durability, and maintenance of the buses tested.

The steps involved in the program include selecting retarders suitable for bus applications, procuring the retarders, testing the retarders in revenue service, and analyzing the data.

Three retarders were selected for testing: the engine brake by Jacobs, the hydraulic retarder by Detroit Diesel Allison, and the electric retarder by Telma. A fourth type of retarder, the exhaust brake, was rejected as not suitable for transit applications since it can only be used with a four-cycle diesel engine and most transit buses use two-cycle engines. The electric retarder will be tested on RTS, New Look, and Flxible 870 buses; the hydraulic retarder on the RTS and Flxible; and the engine brake only on the RTS. In addition, RTS, New Look, and Flxible buses will be included as control buses.

Richard Golembiewski, Superintendent of Rolling Stock,
Detroit Department of Transportation

Dick Golembiewski of DDOT described the installation of the retarders on the various bus models. The installation of the Telma retarder on the RTS required relocation of the emergency brake. On the Flxible 870, the Telma retarder will interfere with the floor and the braces supporting the A-frame. Installation of the DDA retarder required modification to the engine cradle, retrofit of the air-conditioning condensor coil, and increased cooling capacity. The engine brake installation presented no problems.

The MDOT study will investigate the "retarder brake life extension factor" defined as the brake wear rate with the retarder divided by the brake wear rate without the retarder. Typical extension factors for different types of retarders are as follows:

Engine brake	1.2 to 1.7	(cost $1700)
Electric Retarder	3 to 6	(cost $5500)
Hydraulic retarder	3 to 7	(cost $6000)

An analysis of Jacobs shows, for an extension factor of three, a net savings of $42,000 over bus service life, 810 labor hours saved, and 27 weeks of downtime avoided. Preliminary results from the MDOT tests show on the RTS bus, a three to four brake extension factor with the Telma retarder and a 1.7 to 1.9 brake extension factor for the engine brake. Brake lining temperatures were 460 degrees C without the retarder and 70 degrees C with the retarder.

Edith Page of Public Technology Inc. informed the group that PTI has written a technology brief on retarders which is now available and will soon be publishing a technology brief on air-conditioning systems.

AIR-CONDITIONING IMPROVEMENTS

a. LAREDO VENTILATION AND AIR-CONDITIONING TESTS

Mike Buckel, Senior Associate,
Booz, Allen and Hamilton

Michael Bucket of Booz, Allen and Hamiltion described testing of the ventilation systems of advanced design buses. The purpose was to evaluate the efficiency of the ventilation system in the event of an air-conditioning failure or for a coach without air conditioning. Effectiveness was defined as the ability of the ventilation system to bring the interior of the coach to somewhere near ambient temperature. Testing begun in the fall of 1979 was cancelled due to weather conditions. Tests resumed in late summer of 1980 using coaches from GMC, VIA(San Antonio), and NYCTA.

The systems evaluated were: (1) The forced air ventilation system that goes into effect if the refrigerant part of the air-conditioning system goes down; (2) roof ventilators or roof hatches; (3) openable window inserts; and (4) large openable windows on the New Look buses. Each bus was instrumented to record the temperature at seated and standing locations, the temperature of air in and out of the ventilation system, the surface temperature of windows, and the ambient temperature, wind, and sky conditions. There were also instruments to measure the velocity of air within the coach.

Two basic test procedures were used: a "warm-start" and a "cool-start" procedure. For the "warm-start," the bus was parked in the sun allowing it to absorb heat to a stabilized temperature. For the "cool start," the bus was parked in the sun with air conditioning on until the interior temperature stabilized. Tests were conducted with the vehicle stationary and continued while the vehicle was moving at 20 and 40 mph.

Results showed that the ventilation system of the advanced design buses was not very effective. It heats the air entering the coach because of engine heat or evaporator fans. In case of an air-conditioning failure, it would be

best to turn the ventilation fans off. Roof hatches were not very effective. Insert windows are more effective because they are closer to the passenger's eye level. In case of an air-conditioning failure with an advanced design bus, the best method would be to turn the ventilation system off and open the roof hatches and window inserts, but this is not nearly as effective as opening the larger windows on the New Look bus. The key to cooling the bus is to get as much air moving through it as possible.

Study recommendations were that small windows are desirable for air-conditioned buses to reduce the thermal load on the refrigerant system. For non-air-conditioned buses, windows should be opened to the largest possible area. Advanced design buses can now be obtained with larger window openings than the models tested.

Other findings of the study were that the cooling capacity of the RTS-04s was better than the Flxible 870 and that the interior temperature of both advanced design buses was higher than the New Look bus because the large area of dark-tinted glazing material absorbed heat. Copies of the report on this testing are available through NTIS.

b. RECENT IMPROVEMENTS

John D. Lowe, Bus A/C Sales Engineer,
Trane Company

Mr. Lowe discussed recent improvements his firm has made in air-conditioning systems. Mr. Lowe noted that the need to design a new air-conditioning system for each new model bus has its advantages. State-of-the-art technology can be incorporated in the design rather than implemented in a piecemeal fashion.

Two major improvements in the Trane air-conditioning system involve the compressor clutch and suction valves. During the early 1970's, the electrical clutch was developed for the air-conditioning compressor. Its design was highly dependent on existing bearing technology. Within the past year or two, this technology has advanced through the development of low profile bearings. This advance in turn allows a stronger, thicker hub that should reduce the number of premature clutch failures these air-conditioning systems have been experiencing.

Another impact factor in clutch operation is the method by which it is mounted on the crankshaft. Trane Co. has a service bulletin out on how to test for proper mounting.

There has been isolated incidences of suction valve failures on the No. 2 and No. 3 cyclinders of the compressor. Such failures, which tend to occur early in the life of the compressor, can fail the whole system if pieces of the suction valve enter into the compressor. Trane was not able to simulate these failures in their laboratories. In the last couple of years, they have used finite element analysis to locate the source of the problem. It appears to be an impact fatigue-related failure. The ring-plate valve moves up and down impacting the top and bottom of the valve plate. A new flexing ring valve has been developed that flexes instead of moving up and down. Extensive field testing of this valve in 2000 compressors has not produced any suction valve failures. Compressors in production right now have this improved valving system.

As to the overall air-conditioning system, Trane believes their new self-contained package is a positive improvement. It only requires four connections to install. The fact that the package is compiled by Trane and undergoes much testing before it leaves the factory means greater quality control.

Trane has an on-going product improvement program to look at alternative methods for compressing refrigerant gases. No dramatic changes will be made in the refrigerant cycle itself. One item developed recently is a solid state temperature controller, consisting of three thermistors, a printed circuit board, and several relays. One thermistor is located in the return air duct sensing temperature in the bus itself, one in the air-conditioned air space, and one measures the ambient temperature. The PC board activates relays which control different parts of the air-conditioning system. The sensor in the conditioned air space prevents the system from overshooting on the reheat cycle, so that a constant temperature is maintained within the bus.

Air-conditioning systems can be designed either by the air-conditioning manufacturer or by the bus manufacturer although the trend seems to be towards design by the air-conditioning manufacturer. Trane Co. prefers to be "in on the ground floor." A lot of properties want custom-designed, air-conditioning systems, but this can be very expensive. The air-conditioning manufacturer

would like to work with UMTA and APTA to develop some bus air-conditioning specifications that different properties could use.

In response to a question on power takeoff failures, it was noted that Detroit Diesel Allison has been testing methods to solve this problem including a viscous damper, a viscous clutch, and a competitive compressor. Mr. Gil Pegg of GMC Truck and Coach added that GMC has selected the viscous damper as the best solution. He also mentioned that power takeoff failures are ultimately the responsibility of the coach manufacturer.

c. FIELD MODIFICATIONS

Thomas Okasinski, Manager of Facilities and Equipment Engineering, Southeastern Michigan Transportation Authority

Tom Okasinski of SEMTA spoke on the need for relocation of the air-conditioning condensor in the GMC RTS buses. These buses have been plagued with: (1) excessive condensor maintenance; (2) engine overheating; and (3) ineffective climate control due to the location of the air-conditioning condensor in the engine compartment. This problem affects the RTS-01 and RTS-03 buses. The RTS-04 bus has its condensor located outside of the engine compartment.

The location of the condensor in the engine compartment requires frequent cleaning, sometimes weekly in the summer months. This results in $700 extra in labor costs per year per bus. The New Look bus required only annual or semi-annual cleaning. The location of the air-conditioning condensor next to the radiator also affects the engine cooling system which in turn affects the transmission cooling system, leading to transmission failures.

To date four properties have tried removing the condensor from the engine compartment and relocating it elsewhere on the bus (San Antonio, Baltimore, Detroit, and Houston). In total, only 10 buses have been affected by these actions while there are still about 4000 buses across the country with this problem. San Antonio and Detroit have applied to UMTA for capital grants to relocate the condensors on the rest of their RTS bus fleet. They cite operating and maintenance cost savings as justification for this capital investment. Estimated savings are $6000 per bus per year. Benefits include improved air conditioning, fewer engine overheats, less frequent cleaning, fewer road calls, and improved fuel economy.

SEMTA/DDOT estimates that to have an outside contractor install a New Look condensor would cost between $6000 and $8000 per bus. It would be somewhat more expensive (between $10,000 and $12,000) to install the RTS-04 assembly although there are the advantages of standardization and state-of-the-art technology. Payback on these installations should occur in less than two years.

Wayne Hale, Manager of Maintenance,
VIA Metropolitan Transit

Wayne Hale of San Antonio (VIA) presented slides on the in-house condensor relocation conducted at this property. This relocation was conducted at considerably less expense than prices quoted by GMC and Trane.

Richard Golembiewski, Superintendent, Rolling Stock,
Detroit Department of Transportation

Dick Golembiewski of Detroit DOT discussed the condensor relocation conducted at DDOT as part of the hydraulic retarder installation described earlier. The relocation of the condensor was undertaken because of a concern about heat generated by the retarder. DDOT chose the RTS-04 condensor because of the availability of parts and technical services through GMC Truck and Coach Division. Weight on the rear part of the bus increased by 300 pounds, however, a finite element analysis done by the University of Michigan showed no stress-related problems. These buses have been in operation for 10 months. Tests showed temperatures in the transmission were reduced by 35 degrees F.

Gil Pegg, Coach Parts and Service Manager,
GMC Truck and Coach Division

Gil Pegg described GMC's condensor retrofit kit. GMC estimates that at least one half of the 4000 RTS buses already in service will be interested in retrofit. The installation is simple; the blower fans, electric motors, and electrical connections will be the same. The only difference will be the harness which will integrate with the existing "01" or "03" harnesses. Color coding will be used to make the installation as simple as possible. The cost will be under $5000. The shroud, attaching hardware, and instruction book will come in a separate package from Trane. The weight added to the bus will be about 130 pounds.

GMC will warrant all of the new assembly as an entity and all of the attaching parts for one year. The warranty will not extend to the old parts of the system. The labor required for installation is estimated to be less than one man week. In buses that have high idle time, full lights-on time and full air-conditioning time, it may be necessary to replace the 54-slot alternator with a 72-slot alternator at a cost of about $450.

INNER COIL SPRING SEATING DEVELOPMENTS

Thomas Okasinski, Manager of Facilities of Equipment Engineering, Southeastern Michigan Transportation Authority

At the final presentation of the session, Tom Okasinski talked about changes in bus seating undertaken at SEMTA. In 1978, SEMTA received 78 RTS buses equipped with neoprene foam cushion seats. After a year, the foam began to take a set. American Seating replaced the seats on two occasions, but the problem continued. Subsequently, American Seating installed 50 inner coil spring seats for testing purposes. These seats consisted of a plywood base, an inner coil spring, a celletex pad, and a one-inch-thick neoprene topping. These seats held up very well. They are now specified in all new SEMTA bus procurements. Since SEMTA was ordering advanced design buses, they had to obtain a waiver from UMTA. The waiver was granted since the seats did meet the fire retardant properties of the White Book specification. These seats currently cost as much as the foam seats, but should be about 10 percent cheaper when mass produced.

WORKING GROUP 2:
Fleet Maintenance & Rehabilitation

Chairperson:
Frank J. Cihak
Director, Technical and Research Services,
American Public Transit Association

Working Group Organizer:
Neil Patt
Urban Systems Division
Transportation Systems Center

UNIT OVERHAUL AND REPLACEMENT

Edward Tanski, Vice President of Equipment and Maintenance, Niagara Frontiers Transit, Metro Systems, Inc., Buffalo

Mr. Tanski began his presentation by outlining some of the alternatives that a manager has when deciding on whether to replace a bus unit or rebuild it. If replacement is selected, there are many sources that will need to be compared including the original equipment manufacturer, other suppliers, and rebuilders; if repair is more appropriate, then the manager must decide whether to do it in-house or contract the work out. In weighing the pros and cons of each possibility, variables such as the property's manpower needs, time allocations, relative costs, and others must be considered before making a final decision.

The decision to rebuild or replace is further constrained by two significant and contradictory trends. On one hand, buses are equipped with increasingly complex components while, simultaneously, there has been a decline in the experience level of maintenance personnel to work on them. The following points suggest areas of research and development that would aid transit properties in overcoming these circumstances:

- Maintenance Worker Training Programs. We need comprehensive training programs to prepare mechanics for working on complex components. Training should start from the basic mechanical principles as well as the more elaborate methods involved in rebuilding and testing.
- Worker Motivation. Closely related to training is the need for increased employee incentive. Results of efforts made in the industry should be investigated and shared with transit operators. For example, the National Cooperative Transit R&D Program, "Job Enrichment in Transit" could be useful because it relates to maintenance employees and first line supervisors as well as with bus and train operators.
- Information Recall System. Bus maintenance histories are presently kept on work sheets that are difficult to maintain and time-consuming to use. We need to develop a fast, inexpensive, and easy way to use a computer reference system for mechanics and front line supervisors. The fast recall provided by the computer would tell the employee the

date of a rebuild, who did it, and what parts were used. Ultimately, this would help the workers forestall future problems by having a history for a given unit on the vehicle.

- Repair vs. Buy Decision Guidelines. While these decisions are made informally, an outline of tradeoffs and cost benefit analyses would assist in reaching optimum decisions.

MAINTENANCE AIDS

Greg Mitchell, Rolling Stock Office,
Detroit Department of Transportation

Mr. Mitchell described a U.S. DOT sponsored demonstration program in Detroit called "Job Performance Aids" (JPA). This demonstration is aimed at minimizing the 50 percent error rate Detroit has experienced in bus repair and diagnosis. One reason for the high rate is that the standard maintenance manuals supplied by manufacturers do not always contain clear information for shop personnel. In response, the JPA is designed to supply only the needed maintenance information to mechanics and on-line supervisors in usable terms.

Final products are booklet sets that instruct readers in troubleshooting and repair for the bus unit involved. To ensure practical application, the JPA is constructed, reviewed, and approved with in-house maintenance personnel. So far, Detroit DOT has produced JPA's for the heating/air-conditioning, electrical, and transmission systems of the RTS-II. Other units will be covered in the future.

The demonstration program will benefit other transit properties due to its easy transferability. The only caveat for use by other systems is that care should be taken to review the manuals and fine tune the material to incorporate local internal procedures and constraints. Mr. Mitchell also remarked that one of the major problems is finding a successful way of making the manuals convenient to the maintenance personnel on site. He has tried books stored in the foreman's office or complete JPA sections in reference book form, but these have proven unwieldy. Investigation of this, of course, will continue.

The following technical assistance projects were identified as future needs:

- Complete Detroit DOT's demonstration, and to
- Disseminate project updates and results to the transit community.

OVERHAUL QUALITY CONTROL AND RELIABILITY

Francis J. Coletti, Jr., Superintendent of Technical Services, Massachusetts Bay Transportation Authority

While introducing the topic of Quality Control (QC) and reliability, Mr. Coletti stressed the importance of the relationship between the two. When QC is improved, there is an increase in vehicle reliability.

Quality control entails checking rebuilt units prior to bus installation to ensure that it will perform well. The critical time for this check is when the unit enters the rebuild phase after the disassembly, cleaning, and component replacement tasks are accomplished. Replacing key components within a unit is no guarantee that the unit will function well; the component failure could have been caused by other conditions within the unit that only a QC check could discern. Without such detection, premature failure results. It is important to recognize, incidentally, that we have the technology and know-how to conduct effective QC. While the required bench tests and procedures are well capitalized for rail systems, bus systems are deficient in this respect.

Mr. Coletti discussed the issue of reliability and cited the lack of adequate vehicle maintenance recordkeeping as the biggest obstable to discerning changes in vehicle performance (without a method of measuring, management cannot evaluate QC programs to determine efficiency). Admittedly, recordkeeping is difficult due to the number of vehicles and individual components involved and the scarce resources available. Utilizing the methods used in warrantee documentations as well as computer technologies, we should be better able to direct maintenance and QC efforts.

Final technical assistance efforts were identified:

- Quality Control. There is a need to develop cost/benefit studies to clarify, for higher levels of transit management, the ways in which QC programs are cost-beneficial.

- Reliability. R&D needs to be focused on the development of accurate recordkeeping methods to measure and respond to a system's maintenance performance.

MAINTENANCE EQUIPMENT AND FACILITIES

Val Eikanas, Chief Engineer, DeLeuw Cather & Company, Boston

Mr. Eikanas stated that the fixed maintenance equipment at many transit systems does not always perform as well as expected. The problems are the result of an incapatibility between the fixed equipment and the rolling stock and stems from a lack of coordination, especially in the design phases, between the manufacturers of fixed equipment and of buses.

Poor results were then described with bus lifts, washing equipment, fueling facilities, and maintenance garage doors. For instance, the design of bus lifts did not allow for the wheelbase of the Grumman 870. On the other hand, certain buses were designed with poorly placed lift pads that would not work with available bus lifts.

Problems with maintenance equipment procurement specifications further complicate the picture. While they give information about dimensions and capabilities, they do not specify performance standards. Therefore, properties will accept a piece of machinery that sometimes functions below par.

To remedy the situation, the following research and development needs were identified:

- Feedback System. Maintenance equipment designers and users need a forum to exchange information about how maintenance equipment is performing on the field. This would help ensure that appropriate design modifications are made.

- Coordination Between Manufacturers. A method of communication needs to be developed between the makers of buses and fixed equipment so that designs can be made compatible.

- Maintenance Facility Design. Mr. Eikanas referred to the "Planning Design Manual" as an excellent aid to the preliminary designing of a bus maintenance facility. He recommended that the effort be expanded to include more thorough detail about planning and selection processes.

- Handicapped Accessibility. Although E&H regulations apply to maintenance facilities, there is a question as to what levels of access are required as well as to what types of facilities should be provided.

- Money Handling. The removal of money from fare boxes at the service island is an area of debate. More research on various methods would be useful.

AUTOMATIC BUS DIAGNOSTICS

Donald Cameron, Director of Technical Support
New York City T.A.

Donald Cameron introduced Marty Feuerstein, director of the Automatic Bus Diagnostics System (ABDS) demonstration at the New York City Transit Authority, to make the presentation.

Mr. Feuerstein first showed a videotape on the status of the ADBS program. The stated goals of the project were to:

- increase the operating effectiveness of the bus fleet by detecting component problems before they get serious and result in bus downtime and heavy repairs; and by keeping accurate ongoing records of repairs and fluid consumption to aid in detecting and preventing bus breakdown, and to

- reduce maintenance costs by averting major repairs and minimizing maintenance trail and error and confirming that the correct repairs were completed.

The technology to accomplish this consists of a computerized console at the fuel island for daily checks and one at the maintenance area unit for more detailed inspections. Forty New Look buses were modified with add-on sensors that give readings for fluid pressures and electrical system checks when coupled with the computer consoles. The technology is designed to be used by existing maintenance staff without specialized training.

The present ADBS is a pre-prototype model utilizing add-on modifications and wiring. Hence, the real costs and benefits are, at best, estimates. Therefore, action items are to:

- complete the development of the ADBS. As pointed out during the discussion, this would include more demonstration and design as well as the development of production models.
- simultaneously, more information regarding system cost (on a per bus basis) needs to be developed.

BUS REHABILITATION

Phil Dyer, Representative, Pacific Bus Rebuilders', Inc.

Bus rehabilitation is of increasing interest to the transit industry as a way of meeting tighter budgetary constraints while at the same time maintaining levels of service. With an average price of $35-85,000, it is a way to put a bus in service at about half the price and in one-third the time as a new vehicle. Mr. Dyer stated that rehabs are not a substitute for new bus procurement, but should be viewed as a supplement. The rehab industry has the capacity to absorb the increasing demand - while in 1981, 1000 buses were rebuilt, there exists a capability to rehabilitate 4000 buses per year.

Research and development needs were identified and are intended to help give the transit manager the information needed to decide on rebuilding. They include:

- Cost/Benefit Comparison Between Rebuilding In-House or Contracting Out. There is a need to develop a framework to aid properties in assessing the alternatives. For instance, an in-house rebuild includes hidden expenditures such as labor, fringe benefits, extra inventory, storage, and space (in addition to the direct costs) which need to be quantified.
- Specification Guidelines. These guidelines need to be developed to help systems formulate their rebuilding needs and for use in contract negotiations.
- Bus Rehabilitation Manual. Mr. Dyer identified the need to continue the development of the manual, which is being produced by Battelle/ Columbus Labs under contract to UMTA.

WORKING GROUP 3:
Vehicle Procurement

Chairperson:

James H. Graebner
Director, Santa Clara County
Transportation Agency

Working Group Organizer:

Richard Gundersen
Urban Systems Division
Transportation Systems Center

PROCUREMENT REGULATIONS AND FUNDING

Arlan Eadie, Chief, 3rd Party Contract Review
UMTA

In his discussion involving vehicle procurements, Mr. Eadie reminded the group III participants that the "White Book" ("Baseline Advanced Design Transit Coach Specification"), dated October 1981, is scheduled to be phased out effective October 1982. The document may be kept up-to-date, however, for voluntary use by grantees. A final decision on these points must be made by the Secretary of DOT. However, the "White Book" does not meet current requirements for life-cycle costing (LCC).

There has been some discussion about using the "White Book" together with the offset procedure to comply with the life-cycle cost mandate. With elimination of the offset method, however, this approach would be clearly insufficient. Wording in the FY82 Appropriations Act requires UMTA to be assured that life-cycle costs are evaluated by grantees prior to awarding a procurement contract. It is no longer adequate to merely consider LCC. Mr. Eadie stated that in his option even if the offset method were used again, the use of the "White Book" would still not comply with the requirement to evaluate life-cycle costs. The principles behind the offset procedure, however, could successfully be used to create a procedure that would comply with the LCC mandate.

It is UMTA's position that UMTA will not get involved in life-cycle costing protests, except in "arbitrary and capricious" situations. In order to substantiate a greantee's position on the sufficiency or adequacy of the life-cycle cost data or procedure used, that agency should look to relevant decisions of the Comptroller General, Court of Contract Appeals, or State court or administrative decisions in states now using LCC. Protests concerning the application of the LCC procedure must be handled at the local level. The fact that UMTA will not get involved in LCC protests does not mean that the Comptroller General will not. UMTA is currently working on recommendations for simplified life-cycle costing.

UMTA Circular 4220.1, dated 4/15/82, adds UMTA's own requirements to OMB Circular A-102. DOT Order 4600.9B, Chg. 1 covers implementation of Attachment O of OMB Circular A-102 for the Department. These new requirements will be provided to the grantees through the regional offices. When a transit agency's

procurement system meets these requirements, UMTA review of many types of procurements will not be required. UMTA would like to provide regional training in procurement practices that would cover contract principles as well as more detailed requirements. Courses would be designed both for the novice and seasoned staff at transit authorities.

Concerning what recourse a buyer has if a manufacturer's claims for vehicle durability or performance do not measure up to written statements, Mr. Eadie responded that very careful analysis and checking of manufacturer's data should take place before a procurement decision is made. It is very often too late to do anything about the problem after the purchase is made. Solicitation documents should define exactly what is required. In addition, during the prebid conference, the purchaser's requirements should be reviewed and clarified so that they are fully understood by potential bidders.

LIFE-CYCLE COSTING

Bernard Ruble, Principal Transit Planner
Rhode Island Public Transit

In 1980, RIPTA solicited bids for 34 ADB's using life-cycle cost evaluation. As a test case, the procurement ran into some serious problems because there were no clear guidelines relative to life-cycle costs, standardization, or performance.

RIPTA's first attempt at the LCC procedure involved comparing bidders' data with costs experienced in its own fleet. A better method might be to compare data on cost drivers among bidders only. In addition, the authority opened the technical proposals at the same time as the cost proposals. This approach, in retrospect, was not effective since the price could bias evaluation of the technical proposals and the purchaser has no opportunity to go back to manufacturers for additional data or clarification. In summary, classical LCC procedures were not used in the first attempt at RIPTA. The best that could be said is that the experience was educational.

Specifically, RIPTA learned that the purchaser must clearly define what is expected from bidders. For example, a clear understanding of testing and test data requirements are essential. Mr. Ruble expressed a preference for performance data from test tracks over data on foreign experiences. The need for

commonality of data favors test track data. Another lesson learned is that manufacturers should be provided with the method to be used in estimating the fuel economy of the vehicle. In this case, RIPTA used the "White Book" profile for fuel economy of a non-air-conditioned bus. In addition, sufficient supporting data must be requested to perform cross comparisons of technical bids.

Mr. Ruble commented that there is no clear understanding of how to interpret "standardization," and "performance" evaluations. Under performance, RIPTA looked for "performance of the manufacturer to provide the specified vehicle" they asked specifically for training manuals and 100 percent performance bond. (It is doubtful whether this requirement could be used again unless by local requirement it is mandatory.) Yes or no responses were used to evaluate performance of the manufacturer.

Lastly, Mr. Ruble suggests that purchasers use a two-part bid opening. Mr. Ruble made a strong recommendation for:

- Technical specifications, which will be opened the day of the bid opening.
- Pricing bid, to be opened ten (10) days later, in case the buyer has any question about the technical specifications. The price bid opening can be further delayed if necessary.
- Caution must be exercised to exclude bid bonds from the technical proposal.

RIPTA is now out for bid for 42 ADB's using the lessons learned from the first procurement.

There was some discussion concerning the effect of "standardizing" on existing fleets. It was concluded that without further research, no resolution could be obtained in this gray area between inventory cost reduction, maintenance equipment savings, and price competition.

Additional points brought out in discussions were that the burden of proof of any claim that the purchaser was arbitrary or capricious is on the protesting manufacturer, and APTA has the responsibility of making recommendations on LCC procedures to UMTA by the end of May 1982.

MULTIYEAR PROCUREMENT, STANDARDIZATION, AND BASE PRICING

J. David White, Director of Materials
Massachusetts Bay Transportation Authority

Mr. White is a strong advocate of multiyear procurements. He feels that there should be a standard procurement practice in the industry; specifically, five (5) year procurements are recommended.

Although multiyear procurements conflict with the yearly federal appropriation cycle, the potential benefits make this approach worth pursuing. Typically, the orders from one property would be distributed over the year such that the purchaser receives a certain portion of its delivery in each quarter of the year. At the end of each year, the purchaser could choose the option to order the next segment of the multiyear order.

A multiyear procurement provides the following benefits:

1. It would permit more efficient planning by the operator;
2. It will allow properties to project their requirements for a four-year to five-year period, e.g., the purchase of 100 buses per year or 25 buses per quarter;
3. It allows for a systematic maintenance program and facilitates standardization to achieve lower training and inventory costs;
4. It allows the purchaser to incorporate needed change orders to the bus to improve or correct the design prior to receiving the complete order;
5. It eliminates peaks and valleys in the procurement process;
6. It allows the manufacturer to establish a major portion of his five-year bus production schedule;
7. It allows for manufacturer's production flexibility; and
8. It eliminates costly proposal preparation/review time.

With regard to procurement costs, it would be necessary to establish escalation formulas to cover changes in wages and materials over the term of the multiyear option. These escalation formulas exist in associated areas and are accepted in the industry.

Mr. White feels that the composition of a property's existing fleet is an important consideration in "standardization" evaluations. Also, it would not be arbitrary and capricious to consider the trade-in value of the vehicle in performing LCC evaluations.

VEHICLE TESTING FROM A MANUFACTURER'S VIEWPOINT

Clarence I. Giuliani, Sr., Vice President, Customer Services, Neoplan USA

Mr. Giuliani, in discussing vehicle testing, voiced some apprehension with regard to prototype testing. Prototypes are generally built by engineers and are usually not "real world" vehicles. By the time production vehicles are made, they are often a completely different product. There is always a danger in selecting a sample for tests. Mr. Giuliani noted that tests of the Neoplan buses delivered to MARTA (Atlanta) are not representative of the Neoplan ADB. Rather they are merely tests of the MARTA bus. Results could be erroneously extrapolated.

The author also suggests, in fairness to the manufacturer, that the evaluation time be cut down as much as possible. If a test program could be developed as a guide for other properties or manufacturers to use voluntarily, then it would become an objective tool for evaluation of the manufacturer's product. Neoplan supports this approach. The test program should be both rapid and logical. It must be fair to the buyer, but not to the extent that it permits bureaucratic manipulations.

Testing of performance criteria that are quantifiable (gradeability, fuel economy, acceleration, braking noise, etc.) would be very useful. Other performance requirements are more subjective (i.e., driver acceptance, reliability, ease of maintenance) yet they need to be considered. All parties involved must understand the scope and content of all tests and intended use of data.

It was also noted by Mr. Giuliani that long-term tests of already proven components are very unfair to the manufacturer and should not be part of the testing program.

The results of all tests should be given to the transit operator for review and evaluation. Beyond that, the manufactuere has a right to know to whom the test results will be disseminated.

TESTING OF NEW TRANSIT BUSES - NEEDS OF THE SMALLER TRANSIT AGENCIES

Louis Schulman, Administrator
Norwalk Transit District

Mr. Schulman elaborated on his experience at Norwalk Transit District with a relatively small system of 25 buses, its special problems, and how the District responded to these special needs.

Specifically, Mr. Schulman focused his remarks on the progress and preliminary findings from his revenue service test of three 40-foot Scania, 112 transit coaches. The test and evaluation started in the Fall of 1981 and will run for one year. His comments addressed the reason for his agency's interest in this type of project and the result of possible benefits that could affect the vehicle procurement process.

Mr. Schulman's district was interested in testing a vehicle which could demonstrate high fuel economy and increased component life in order to address major cost drivers in his system. The tests on European-made Scania buses have resulted in an average of over five miles per gallon. Through the use of oversized brake linings and a retarder on the transmission, brake life has improved prior to the previous experience with the other fleet.

Norwalk Transit District was looking for improved handling characteristics in their buses which the Scania bus was able to provide. The Scania bus manufacturer set back the front wheels and as a result, the vehicle does offer a smaller turning radius and improved maneuverability over other buses in their fleet. The Scania bus is also very quiet due to added insulating material between the engine and the passenger compartment.

The GM buses are still the mainstay of the Norwalk system. For economical reasons, the concern for improved fuel economy and noise reduction made it worthwhile to examine and test new vehicles that appear to meet the needs of the community being served.

The importance of this evaluation project to the procurement process is two-fold:

1. It permitted the introduction of a new vehicle to the U.S. transit community for an assessment by the riding public, vehicle manufacturers, and public transit agencies;

2. For properties similar to Norwalk Transit, who perceive special needs and request innovative equipment through regular procurement processes or through the New Bus Equipment Introduction program, UMTA will be in a position to say that such equipment exists and has been proven in transit revenue service.

In responding to a question about the reduced turning radious, Mr. Schulman stated that there has been no problem relative to the rear overhang — at least in the Norwalk area. Another question — , "What did you give up to get the high MPG?" — resulted in a response that the weight was considerably lighter in the Scania bus, although other factors in the design of the drive train might contribute significantly as well.

VEHICLE QUALITY ASSURANCE PROGRAMS

Peter Ward, Senior Manager of Operations and Maintenance
ATE Management and Services Co., Inc.

The quality assurance process pertains to the procedures and actions that should be taken after contract award to ensure that the bus is delivered to the property in the agreed condition. Mr. Ward's comments focused on what the APTA Bus Quality Assurance Subcommittee has developed for the quality assurance process.

The following perceptions were offered:

1. The quality assurance process should be considered an important part of the overall fleet maintenance process;
2. Decisions on whether to replace or rehabilitate should be based on the economics at the appropriate time;
3. Specifications must establish a good understanding between the builder and the operator; the writing of a clear specification is imperative. Writing the specification for rebuilding may take more care than writing the specification for a new vehicle.

The fleet maintenance program consists of the following important points:

1. Monitoring quality assurance (after arrangements are completed to buy the vehicles);
2. Developing inspection plans;

3. Developing a preventive maintenance program before receipt of buses,

4. Developing an information system to capture technical data on the vehicle and to analyze problems for future reference.

The first part of the quality assurance monitoring program begins with the prebid conference. This is followed by the post-bid, precontract conference where the successful bidder meets with the property to work out exact details of the procurement, including specifying subsystem manufacturers.

The next item in the program is the pre-production quality review meeting between manufacturers and inspectors to agree on exactly what items are important to each party involved. A key point is that the inspector's job is to examine the quality assurance process itself, not to conduct the inspection for the manufacturer.

Another important point to remember in the quality assurance process is that the inspector must be consistent in applying the monitoring technique. One of the things to avoid is changing or rotating inspectors and the inherent inconsistency associated with such continued change. In addition, the whole monitoring process should be well-documented. This includes completing daily or weekly inspection forms. A suggestion was made that the first bus be used as an example or model for mutual agreement by all parties as to what the final vehicles will look like. This could avoid numerous problems or disagreements later. Establishment of workmanship criteria is important to consider at the pre-production meeting with the inspector at the plant. Problem identification and the followup action must be documented and such documentation should remain with the bus. When delivering the bus, this documentation and records of any changes should be provided to the purchaser.

The role of inspector at the factory is not to be an engineering evaluator, but rather a quality control inspector. A large majority of problems, from a vehicle manufacturing perspective, are due to interpretation of design or cosmetics. The consensus of the attendees was that the quality assurance program, currently available in the "White Book," is useful and should be used even after the other parts of the specification become nonmandatory. In this regard, the Bus Technology Liaison Board recommended that parts 1, 3, and 4 of the "White Book" remain as the basis of bid packages in the future. Consistent guidelines for inspection are needed. An APTA subcommittee is developing such guidelines for voluntary use.

Toward the end of Summer 1982, APTA will produce estimates of this procedure and will present it in detail.

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